Living animal almost black with bluish-green sulci, or with longitudinal black stripes on tail; lower tentacles with pale tips; eyes small and ommatophores not much enlarged apically; mantle-collar and lappets bluish-green; tail almost cylindrical. Has habit of raising anterior end, which is longer than tail, off the ground. Anatomy similar to *A. concolor*, but mantle-glands less deeply invading; lung about 6 times as long as its base or over 2.5 length of kidney, which is slenderer and about twice its base or pericardial length. Genitalia very similar but penis relatively larger and more stoutly fusiform, with terminal entrance (DE) of vas deferens (D); internally (f. 9, opened out), more spongy epiphallic chamber (E; sometimes containing a soft spermatophore) demarcated largely by an ovoid thickening (EP); middle region of penis (P) containing a large papilla (PP) with apical half recurved, digitiform and free; basal part with a pilaster (PP'), which continues halfway down atrium (Y; mostly omitted). Jaw apparently represented by a very much wrinkled plate, which is usually doubled around jaw fold but appears weakly cornified. Radular formula (f. 8): 24–25 + 0 + 24–25; 49 rows counted; inner 4 or 5 teeth similar, increasing rapidly in size; others developing sharp wings on either side of tip, attaining (9th or 10th) almost 0.5 in length, then gradually decreasing (to 23rd) and finally diminishing rapidly until last is about 0.6 as long as first. [T shows shape of right half of a crowded posterior row; anterior ones may expand to over twice as long.]

The structure of the penis and the expanded tips of most radular teeth indicate that *A. alticola* is a very distinct species from *A. concolor*. Also, no intergradation in their shells has been seen, although *A. alticola* sometimes has fairly evident varices on a diluted background. The oviparity of this highland species seems probable but is not completely proven.

AQUARIUM BEHAVIOR OF *EUNATICINA OLDROYDII* (DALL)

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The specimens of the Gastropod, *Eunaticina oldroydii* (Dall), upon which this paper is based were obtained in October, 1937, by means of a beam-trawl of the kind commonly used by Monterey Bay fishermen in obtaining flounders. Twenty animals

were taken in approximately 20 fathoms of water off-shore from Elkhorn Slough, which empties into Monterey Bay. An additional 5 specimens of uncertain locality other than Monterey Bay were supplied through the courtesy of the Hopkins Marine station of Leland Stanford Jr. University. The animals were brought into the Agassiz laboratory of the marine station and placed in marine aquaria supplied with running sea water. A sand bottom was provided in an attempt to approximate a natural benthonic habitat.

Data listed here include method of reproduction, formation of the egg collar, movement, and burrowing by *Eunaticina.*

The fact that 20 specimens of *Eunaticina* were collected from one locality by the writer, and that the 5 presented to him by the Hopkins Marine Station were also collected together, possibly indicates that this mollusk is a gregarious one. Ideal bottom conditions no doubt bring individuals naturally together. Individuals thus form aggregates to enjoy ideal environmental conditions offered by only restricted areas of sea bottom.

Copulation.—The act of copulation was observed once among the animals kept under observation in the aquaria. The opening of the genital duct in both male and female of this dioecious species is located at the base of the columellar muscle on the right side of the animal, necessitating an approach of the sexes in opposite directions preparatory to the copulatory act. In the instance under observation this process occurred while both animals were active on the surface of the sand in the aquarium. The male was the aggressor; approaching the female "head-on" in order to bring the penis in close proximity to the external genital opening of the female. The male inserted the penis into the vagina on the fourth attempt. His failure in the first attempts was due to the temporary obstruction caused by the right dorsal margin of the propodium, which rests in front of the vaginal opening, and had to be forced aside before the external sex organs could come in contact with one another. The copulatory act consumed 47 minutes. During the process slight muscular contractions and expansions passed over the foot. No actual purchase upon one another by use of the foot was attempted by either sex during the act.

Egg Collar Formation.—One egg collar, characteristic of the *Naticidae,* was observed still in the gelatinous state, but in such a condition that no measurements of its diameter or circumference could be obtained. This collar was adhering to a female which had been removed from under the sand in an aquarium and killed for dissection. The collar was in place around the foot under the dorsal extensions of the propodium, mesopodium, and metapodium. A dissection of the oviduct showed that it was distended with eggs embedded in a mucous mass. This information together with other available data on the anatomy of the female genital tract, and field knowledge about completely formed collars in related genera of the *Naticidae, Polinices* and *Natica,* make possible the reconstruction of the egg laying process given below.

Gross dissections of females with ripe ovaries indicate that there are two general histological divisions of the oviduct, namely, a proximal non-glandular portion, and a distal glandular portion. Eggs occupying the extent of the oviduct were found in two females. The eggs in the non-glandular area lacked the addition of the mucous mass, while those in the glandular portion were embedded in mucous.

The egg mass in the captive individual was apparently secreted while the female was under the sand. The first eggs to be forced from the oviduct are apparently directed by the pressure of the succeeding eggs, since the distal half of the oviduct is glandular rather than muscular. On reaching the external genital opening, the eggs in the mucous mass are directed around the shell between it and the dorsal expansions of the three foot divisions until they make a complete circuit of the shell. When this circuit is completed the initial part of the gelatinous mass overlaps the portion which is still issuing from the oviduct. Since the egg mass is held in place between the shell and the foot divisions it is prevented from floating away until the collar is complete. Sand is apparently allowed to accumulate between the foot and the shell during the egg-laying process, for the presence of innumerable sand grains in the incomplete egg collar of *Eunaticina oldroydii* (Dall) and in mature collars of *Polinices* and *Natica* seems to indicate that sand is a mechanical factor which serves to give

them stiffness. Egg collars collected in the Monterey Bay region offer evidence that they are allowed by the female to float free after they have been completed. The writer has often observed similar collars of *Polinices* in the mud-flat region of Balboa Bay, California, both in place and floating. Johnson and Snook (1935), concerning egg collars of *Polinices lewisii* (Gould), *P. draconis* (Dall), and *P. recluziana* (Deshayes), state, ". . . the eggs are laid in a gelatinous sheath which is apparently moulded over the foot of the animal for it is about the same size, and shaped like a collar. These "collars" are encrusted with sand. . . ."

Movement.—Movement in this species of *Eunaticina* is accomplished by waves of contraction initiated at the tip of the metapodium. These waves pass over the mesopodium and terminate at the anterior extremity of the propodium. The animal, by means of the transversely situated mucous gland located at the posterior-ventral portion of the propodium, secretes a viscous substance which is laid down on the substratum, and over which the mesopodium and metapodium pass with ease.

The animal precedes forward movement by a cautious testing of the substratum with the tip of the propodium; if the substratum is satisfactory it moves ahead; if not it bends the propodium laterally and turns to one side. In the aquaria it was often observed that if a rock were placed in the path of one of the animals, it made no effort to try to surmount the obstacle, but instead turned aside and moved around the rock or reversed its initial path of progression. The activity of these mollusks as observed in the aquaria was nocturnal rather than diurnal.

Burrowing.—The time consumed in burrowing, from the surface of the sand until the animal assumed its normal resting position under its surface, was recorded for twelve individuals. This time varied from one minute and fifty seconds to three minutes, with an average of two minutes and fifteen seconds for the animals subjected to these tests.

The means by which the mollusk accomplishes its burrowing are quite interesting. Crawling over the aquarium bottom, apparently trying to find a suitable place to burrow, it tests the surface from time to time by lifting the tip of the propodium and

pressing it against the sand. The highly developed, muscular tip of the propodium serves also as an efficient wedge in forcing an entrance into firmly packed sand. When a suitable location is found the animal thrusts the tip of the propodium downward and turns it back and forth. The mesopodium and the metapodium are held parallel to the bottom on the surface of the sand for purchase, while the propodium pushes the sand from side to side. When the propodium is well submerged the mesopodium and metapodium are raised free from the bottom at an angle comparable to that at which the propodium first entered the substratum, and twisting them both from side to side, accompanied by additional lateral movement of the propodium, the animal makes its final entrance. The body of the animal is then adjusted so that the sole of the foot is parallel to the bottom of the aquarium. This final position was observed always to leave the apical whorls and the pseudosiphon projecting from the sand, thus, apparently, allowing the animal to control the water content of the mantle cavity.

It is to be understood that the observations included here were made in aquaria. They should not be thought of as applying to this species in its natural habitat. Exceptions to scientific rules exist throughout the animal kingdom; the included data may be only one phase of egg collar formation, copulation, burrowing, and movement. When more of these animals are studied no doubt variations in carrying out actions cited here will be found.

I wish to express my gratitude to Dr. Taga Skogsberg, who first interested me in the study of this mollusk at the Hopkins Marine Station of Stanford University.

BIBLIOGRAPHY

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NOTES AND NEWS

THE BEAL COLLECTION.—The large and valuable collection of shells assembled by Dr. J. H. Beal, of Merritt Island, Florida, and presented by him to Rollins College, was opened to the public